



**Johnson Space Center
Procedural
Requirements**

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SAMPLING AND VALIDATION TESTING OF RAW MATERIALS AND GASES

Responsible Office: Safety & Mission Assurance Directorate

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Change History Log

Revision	Effective Date	Originator / Phone	Description of Changes
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Preface

P.1 PURPOSE

JPR 5335.6 defines the implementation for the Johnson Space Center (JSC) Sampling and Validation Testing of Raw Materials and Gases Program. The purpose of the program is to ensure compliance with AS9100, Quality Management Systems – Aerospace Requirements.

P.2 APPLICABILITY

JPR 5335.6 governs the sampling and validation testing of raw materials and gases and is applicable to all JSC areas where critical and complex work is performed.

P.3 AUTHORITY

(All document citations are assumed to be the latest version unless otherwise noted.)

NPD 8730.5 *NASA Quality Assurance Program Policy*

P.4 APPLICABLE DOCUMENTS

(All document citations are assumed to be the latest version unless otherwise noted.)

See § 6.0

P.5 MEASUREMENT VERIFICATION:

The OPR shall periodically assess effectiveness of the program through periodic audits.

P.6 CANCELLATION/RECISSION:

None

Sampling and Validation Testing of Raw Materials and Gases

Approved by:

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1.0 PURPOSE

This JPR identifies the processes for periodic validation of test reports of raw materials and gases. These processes are designed to evaluate purchased raw materials and gases where acceptance utilizes material test reports for product acceptance. These processes are intended to provide confidence in the vendor/supplier base.

2.0 SCOPE

This JPR is applicable to all raw materials and gases utilized in the fabrication and operation of both spaceflight hardware and ground systems having a crew interface. This JPR is applicable to NASA-JSC and its contractors engaged in program and project support.

3.0 DEFINITIONS AND ACRONYMS

3.1 Definitions

Table 3-1 Definitions of Relevant Terminology

Term	Definition
Acceptance Quality Level (AQL)	Acceptable reject rate necessary to accept a lot based on statistical sampling data
Age hardening	Same as precipitation hardening
Conductivity (%IACS)	A nondestructive technique used to characterize the temper in wrought aluminum alloys; SAE AMS 2658 has more information about this inspection technique
Contractor	Organization delegated by NASA to perform a service
Control number	A number assigned by a QAS for NASA tracking purposes
Equivalent laboratory	A JSC Approved, Off-Site Laboratory as identified in section 8.2 of this CWI
Exotic materials	Those materials where chemical analysis standards are not easily available and/or physical and mechanical test properties are not readily defined, propriety, and/or generally not available
Hardness	Resistance of metal to plastic deformation
Heat	The product of a single melting operation in a furnace; precursor to a lot
Heat treatment	Any process involving heating metal to an elevated temperature to obtain change in properties or metallurgical structure
Lot	A mill run or a heat treat batch that is processed together
Lot number	A number assigned by the mill or heat treating facility to a specific lot for tracking purposes
Lot size	Number of pieces within a lot

Term	Definition
Manufacturer	The organization responsible for the physical production of a raw material or gas; for metals this is a mill
Mill Test Report	A written report, similar to a Supplier Material Test Report, provided by the manufacturer to the supplier
Normalized	Heating a ferrous alloy to a suitable temperature above the transformation range and then cooling in air to a temperature substantially below the transformation range
Population	A grouping of lots
Population size	Number of pieces within a population
Precipitation hardenable	The material has capability to be precipitation hardened with mechanical properties at a specified level. Demonstration coupons are taken from the heat lot, age hardened at specification designated level and tensile tested to prove this capability
Precipitation hardening	Hardening caused by the precipitation of a constituent from a supersaturated solid solution
Quenching	A process of rapid cooling from an elevated temperature by contact with liquids, gases, or solids
Raw material	Physical substances used as inputs for production and/or manufacturing and transformed into a new and useful product
Raw material or gas owner	Organization that purchases a raw material or gas
Sample	A part, portion, or piece taken for purposes of inspection or test as representative of the lot
Sample size	The number of samples taken from a lot for validation testing
Sampling plan	A specific plan that states the sample size to be used and the associated acceptance criteria
Solution heat treated	Heating an alloy to a suitable temperature, holding at that temperature long enough to cause one or more constituents to enter into solid solution, and then cooling rapidly enough to hold these constituents in solution
Supplier	Source of purchased raw material or gas
Supplier Material Test Report (Supplier MTR or MTR)	A written report, provided by the supplier, that documents the results of all testing performed and confirms that the raw material or gas complies with specified requirements
Temper	To soften hardened steel or cast iron by reheating to some temperature below the eutectoid temperature
Testing	A laboratory examination of the characteristics of a raw material or gas
Ultimate tensile strength (UTS)	The maximum load in kilopounds per square inch (ksi) that a material sample will carry before breaking under a slowly applied, gradually increasing load

Term	Definition
Validation Material Test Report (Validation MTR)	Written report that documents the results of validation testing
Validation testing	Performance of testing to validate the data on Supplier Material Test Report
Validation test laboratory	Laboratory that performs validation testing and produces a Validation Material Test Report
Vendor	Another word for supplier
Yield strength (YS)	The point at which a material exceeds the elastic limit and will not return to its original length or shape if the stress is removed. The value is determined by evaluating a stress-strain diagram produced during a tensile test and is expressed in kilopounds per square inch (ksi)

3.2 Acronyms

Table 3-2 Acronyms

Acronym	Term
A2LA	American Association for Laboratory Accreditation
AQL	Acceptance Quality Level
AMS	Aerospace Material Specifications
ASQ	American Society for Quality
ASTM	American Society for Testing and Materials, now simply known as ASTM International
CWI	Common Work Instruction
EDS	Energy Dispersive Spectroscopy
EHL	Environmental Health Laboratory
ESTA	Energy Systems Test Area
GIDEP	Government-Industry Data Exchange Program
IACS	International Annealed Copper Standard
MSDS	Material Safety Data Sheets
MTR	Material Test Report
OES	Optical Emission Spectroscopy
QAS	Quality Assurance Specialist
RITF	Receiving, Inspection, and Test Facility
SAE	Society of Automotive Engineers
UHP	Ultra High Purity
XRF	X-Ray Fluorescence

4.0 RECORDS AND FORMS

Table 4-1 Records and Forms

Number Reference	Title of Form
JSC Form 321	JSC Request for Analysis
JSC Form 1264	Mechanical Work Request
JSC Form 2176	Discrepancy Report/Material Review Record
	Supplier Material Test Report
	Validation Material Test Report

5.0 SAFETY PRECAUTIONS AND WARNING NOTES

All personnel shall be required to attend safety courses relevant to the type of validation testing they shall be performing. The validation test laboratory shall maintain a listing of required safety courses.

5.1 Validation Testing of Raw Materials

Relevant safety courses include personal protective equipment, chemical hygiene, hazardous communication, hazardous materials, hazardous waste, radiation safety, electrical safety, and machining. This list is not all-inclusive.

5.2 Validation Testing of Gases

Relevant safety courses include personal protective equipment, chemical hygiene, hazardous communication, hazardous materials, hazardous waste, electrical safety, and pressure systems. This list is not all-inclusive.

6.0 REFERENCES

6.1 NASA Documents

Table 6-1 NASA and JSC References

Reference Number	Title of Document
JPR 1700.1	JSC Safety and Health Handbook
JPR 5335.3	Quality Manual
JSC SLP 4.10	Inspection, Testing, and Traceability
JSC SLP 4.13	Control of Nonconforming Product
NT-QAS-016	Receiving, Sampling, and Storage Control of Fluids (Compressed Gases/Liquid Gases)
NT-QAS-048	Quality Assurance Specialists Responsibilities for Control of Program Stock

6.2 Technical Standards

Table 6-2 Relevant Technical Standards

Reference Number	Title of Standard
ANSI/ASQ Z1.4	Sampling Procedures and Tables for Inspection by Attributes
SAE AS9100	Quality Management Systems – Aerospace – Requirements

6.3 Hardness Testing Specifications

Table 6-3 Hardness Testing Specifications

Reference Number	Specification Title
ASTM A370	Standard Test Method and Definitions for Mechanical Testing of Steel Products.
ASTM E 18	Standard Test Method for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials.
ASTM E 140	Standard Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness and Scleroscope Hardness.
ASTM E 384	Standard Test Method for Microindentation Hardness of Materials.

6.4 Tensile Testing Specifications

Table 6-4 Tensile Testing Specifications

Reference Number	Title of Specification
ASTM A370	Standard Test Method and Definitions for Mechanical Testing of Steel Products.
ASTM B 557	Standard Test Method of Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products.
ASTM E 8	Standard Test Method for Tension Testing of Metallic Materials.

6.5 Dew Point Testing Specifications

Table 6-5 Dew Point Testing Specifications

Reference Number	Title of Specification
MIL-A-18455	Argon, Technical

7.0 TOOLS, EQUIPMENT, AND MATERIALS

The validation test laboratory shall have all the equipment and materials necessary to support validation testing. All testing equipment shall be calibrated per the appropriate ASTM specification.

8.0 PERSONNEL TRAINING AND CERTIFICATION

8.1 Validation Test Laboratory Certification

All validation testing must be done by a NASA-JSC laboratory or equivalent laboratory (JSC approved off-site laboratory per section 8.2). For raw materials, the Receiving, Inspection, and Test Facility (RITF) is the approved NASA-JSC laboratory. For gases, the Environmental Health Laboratory (EHL) and Energy Systems Test Area (ESTA) laboratory are the approved NASA-JSC laboratories.

8.2 JSC Approved, Off-Site Laboratory Certification

JSC approved, off-site laboratories are those that hold accreditations that meets or exceeds the accreditation held by the NASA-JSC laboratory in the subject areas they are validating. A JSC Approved, Off-site Laboratory must be approved by NT (Quality and Flight Equipment Division).

8.3 Personnel Training

All personnel shall be certified by their laboratory for the types of validation testing they shall be performing. The validation test laboratory shall maintain records of personnel certification.

9.0 RESPONSIBILITIES

9.1 Raw Material or Gas Supplier

Supplier shall provide a Supplier MTR for all raw materials and gases.

9.2 Raw Material or Gas Owner

The raw material or gas owner shall coordinate the quarterly validation testing. The raw material or gas owner shall randomly identify a single lot from a single vendor and prepare the necessary number of samples per ANSI/ASQ Z1.4. The raw material or gas owner shall maintain a copy of the Supplier MTR.

9.3 Validation Test Laboratory

For raw materials, the RITF or an equivalent laboratory shall perform the validation tests on the samples provided by the raw material owner and produce a Validation MTR. The RITF requires JSC Form 1264 to request chemical analysis and mechanical testing.

For gases, the EHL or ESTA laboratory or an equivalent laboratory shall perform the validation tests on the samples provided by the gas owner and produce a Validation MTR. JSC Form 321 shall be used to request gas analysis of breathing gases, oxygen, and nitrogen.

For more information see Sections 8.1 and 8.2.

9.4 Quality and Flight Equipment Division (NT)

The Quality and Flight Equipment Division or its delegates shall annually verify the performance of validation testing through internal audits.

10.0 PROCEDURE

The following procedures shall be used to complete the validation testing. The procedures are broken up into two sections: Raw Materials and Gases.

10.1 Raw Materials

This procedure calls out the sequence of steps required to perform validation testing on a variety of raw materials. Materials eligible for validation testing includes a variety of ferrous and non-ferrous alloys.

Table 10-1 Ferrous and Non-ferrous Alloys

Ferrous Alloys:	Non-ferrous Alloys:
Carbon steels	Aluminum and its alloys
Low alloy steels	Aluminum-lithium alloys
Intermediate alloy steels	Copper and its alloys
High alloy steels	Superalloys (i.e. nickel and its alloys & cobalt and its alloys)
Ferritic stainless steels	Titanium and its alloys
Austenitic stainless steels	Lead and tin alloys and replacement solder alloys
Martensitic stainless steels	
Precipitation-hardenable stainless steels	

Ferrous and non-ferrous alloys used as welding filler materials shall only require chemical analysis. Chemical analysis of welding rods shall be performed by OES; chemical analysis of welding wire shall be performed by EDS, XRF or other NASA-approved equivalent process.

Exotic materials shall not require retesting unless otherwise specified by the user or procurement specifications. The following materials are considered exotic:

Table 10-2 Exotic Materials

Exotic Materials:	
Beryllium and its alloys	Platinum and its alloys
Beryllium copper	Rhenium and its alloys
Gold and its alloys	Silver and its alloys
Magnesium and its alloys	Tantalum and its alloys
Magnets and magnetic alloys	Vanadium and its alloys
Molybdenum and its alloys	Zinc and its alloys
Niobium and its alloys	Zirconium and its alloys
Palladium and its alloys	

10.1.1 Supplier Selection

The raw material owner shall compile a list of suppliers at the end of the quarter eligible for validation testing (i.e. have supplied a raw material subject to this CWI per Section 10.1). Any suppliers already subjected to validation testing for the current calendar year shall be removed from the list for the current quarter.

The raw material owner shall randomly select one of the suppliers remaining on the list of suppliers for the current quarter. The name of the selected supplier shall be noted.

10.1.2 Lot Selection

The raw material owner shall compile a list of eligible lots (i.e. lots of raw material subject to this CWI per Section 10.1) from the selected supplier for the current quarter.

The raw material owner shall randomly select one of the lots for validation testing. The lot number shall be noted.

The Supplier MTR for the selected lot shall be retrieved.

10.1.3 Sampling Plan

A sampling plan for the selected lot shall be developed per ANSI/ASQ Z1.4. The following steps shall be taken to develop the sampling plan:

1. The raw material owner shall identify the lot size for the selected lot. This lot size shall be noted.
2. The raw material owner shall determine the sample size using General Inspection Level II per "Table I, Sample Size Code Letters" (ANSI/ASQ Z1.4). The sample size shall be noted.
3. The raw material owner shall establish an acceptance quality level (AQL) based on the hardware criticality and the critical nature of the materials function in that hardware. The AQL shall be 10% or less. The AQL shall be determined per "Table II-A, Single Sampling Plans for Normal Inspection" (ANSI/ASQ Z1.4). The AQL shall be noted.
4. The raw material owner shall randomly select the necessary number of samples to perform validation testing.

10.1.4 Sample Preparation and Submission

The raw material owner, with support from the validation test laboratory, shall prepare the samples.

The raw material owner shall submit the samples to the validation test laboratory for validation testing.

10.1.5 Validation Testing

Validation testing may consist of both chemical analysis and mechanical testing. The validation test laboratory shall produce a Validation MTR and submit it to the raw material owner. The Validation MTR shall indicate any violations of the AQL. These following guidelines shall be used when performing validation testing.

10.1.5.1 Chemical Analysis

Optical Emission Spectroscopy (OES) shall be used for all chemical analysis of ferrous alloys including: carbon steels, low alloy steels, tool steels, and stainless steels. OES shall also be used for all chemical analysis for aluminum alloys, copper alloys, and superalloys (nickel- and cobalt-based alloys). OES shall be used for chemical analysis of welding rods.

OES testing shall require using OES reference standards and material test programs (OES programs) in order to insure accuracy of the chemical test data.

For all titanium alloys, all welding wires, and all solder alloys, a qualitative chemical analysis shall be done by energy dispersive spectroscopy (EDS), XRF or other NASA- approved equivalent process. The spectrum shall be matched with a spectrum from an EDS standard of that alloy.

10.1.5.2 Mechanical Testing

Hardness testing shall be used to approximate the as-received ultimate tensile strength (ASTM A370, Tables 2 and 3) of ferrous alloys whenever possible. Please note that mechanical properties are often not sent with normalized steels because a heat treating operation is almost always performed prior to its use.

Hardness testing and conductivity (% IACS) shall be used to verify the as-received mechanical properties or temper of aluminum (SAE AMS 2658) and copper alloys.

Hardness testing is not an acceptable test method for titanium alloys. Tensile test bars must be used for validation of mechanical properties for titanium and its alloys.

Hardness testing shall be used to validate mechanical properties for solution heat treated superalloys. Hardness values for solution heat treated and aged superalloys shall be validated by SAE AMS 2774.

Superalloys (MP35N, MP159N, etc) and precipitation-hardenable stainless steels (A286) that are work strengthened after solution heat treating and before aging shall be tensile tested to validate mechanical properties.

Lead and tin solder alloys and replacement solder alloys are exempt from mechanical testing.

When tensile coupons are used to validate mechanical properties, ultimate tensile strength, yield strength, and % elongation shall be tested for all metallic alloys other than titanium and its alloys –

titanium and its alloys requires reduction of area in addition to ultimate tensile strength, yield strength, and % elongation. If tensile bars are required, tensile testing to the same specification listed on the Supplier MTR is preferred whenever possible.

10.1.6 Comparison of MTRs

The raw material owner shall compare the Validation MTR against the Supplier MTR and the procurement specification. If the Validation MTR meets the procurement specification then the validation testing is concluded.

10.1.7 Control and Disposition of Nonconforming Material

1. If the Validation MTR does not meet the procurement specification then the raw material owner shall segregate the nonconforming lot and tag it. A Discrepancy Report shall be generated on the nonconforming lot.
2. The raw material owner shall contact JSC GIDEP Alert coordinator and have an Alert generated.
3. Any hardware made from the nonconforming material lot shall be segregated and tagged as well. A discrepancy report shall be generated for each part number.
4. The discrepancy report shall be dispositioned before the material and/ or hardware can be used.

10.2 Gases

This procedure calls out the sequence of steps required to perform validation testing on a variety of gases. The gases subject to validation testing are divided into two categories – Breathing Gases and Laboratory/Manufacturing Gases. This list is not all-inclusive.

Table 10-3 Breathing Gases

Breathing Gases:	Laboratory/Manufacturing Gases:
Oxygen (O ₂), Aviator's Breathing and Medical Grade	Argon (Ar), all grades and mixes
Nitrogen (N ₂), Grades A, B, and UHP	Helium (He), all grades and mixes
Breathing gases, all grades and mixes	Carbon dioxide (CO ₂), all grades and mixes

10.2.1 Sample Preparation and Submission

The gas owner, with support from the validation test laboratory, shall submit gas bottles for validation testing. The type of testing and frequency of testing depends on the type of gas – either breathing gas or laboratory/manufacturing gas.

The gas owner shall note the gas supplier, bottle serial number, and fill date for all gas bottles submitted for validation testing.

The gas owner shall retain a copy of the Supplier MTR for every gas bottle.

10.2.1.1 Breathing Gases

Breathing gases shall be subject to testing as required by JPR 1700.1 “JSC Safety and Health Handbook”, Chapter 6.13 “Safety and Health Requirements for Ground-Based Breathing Gases and Breathing Gas Systems.” The test data shall be reported on JSC Form 321.

Oxygen bottles not intended for human breathing (such as Oxygen "tech" grades) are exempt from validation testing. These bottles are identifiable by black permanently-labeled letters within the 1 inch to 2 inch size range stating "NOT FOR BREATHING".

10.2.1.2 Laboratory/Manufacturing Gases

The gas owner shall compile a list of suppliers at the end of the quarter eligible for validation testing (i.e. have supplied a gas subject to this CWI per Section 10.2). Any suppliers already subjected to validation testing for the current calendar year shall be removed from the list for the current quarter.

The gas owner shall randomly select one of the suppliers remaining on the list of suppliers for the current quarter. The name of the selected supplier shall be noted.

A sampling plan for the selected supplier shall be developed per ANSI/ASQ Z1.4. The following steps shall be taken to develop the sampling plan:

1. The gas owner shall compile a list of eligible bottles (i.e. bottles containing gases subject to this CWI per Section 10.2) from the selected supplier for the current quarter. This shall be considered the lot size and shall be noted.
2. The gas owner shall determine the sample size using General Inspection Level II per “Table 1, Sample Size Code Letters” (ANSI/ASQ Z1.4). The sample size shall be noted.
3. The raw material owner shall establish an acceptance quality level (AQL) based on the hardware criticality. The AQL shall be 10% or less. The AQL shall be determined per “Table II-A, Single Sampling Plans for Normal Inspection” (ANSI/ASQ Z1.4). The AQL shall be noted.
4. The gas owner shall randomly select the necessary number of samples to perform validation testing.

Laboratory/manufacturing gases shall be subject to dew point measurement testing per the methods listed in "Section 4.4.1, Moisture Impurity" of MIL-A-18455. All four dew point measurement methods are valid. The test data shall be reported on JSC Form 321. Only the dew point shall be required.

10.2.2 Validation Testing

The validation test laboratory shall produce a Validation MTR and submit it to the gas owner. The Validation MTR shall contain the data collected by the validation test laboratory.

10.2.3 Comparison of MTRs

The gas owner shall compare the Validation MTR against the procurement specification. If the Validation MTR meets the procurement specification then the validation testing is concluded.

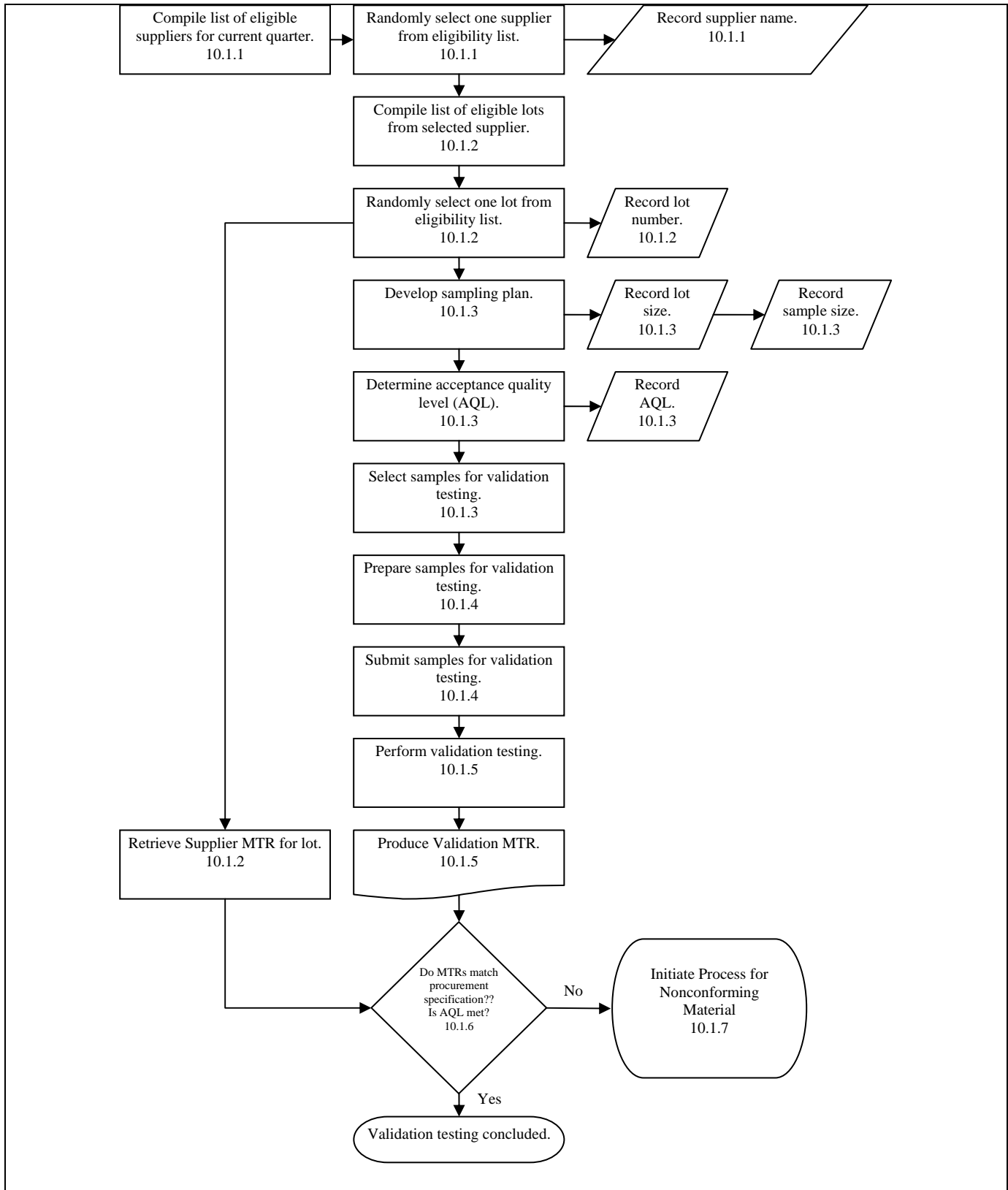
10.2.4 Control and Disposition of Nonconforming Gases

1. If the MTRs do not match procurement specification, then the gas owner shall segregate the reject bottle with a reject tag, and then return it the vendor.
2. A discrepancy report is generated to document the nonconformance. Any other bottle from the same lot and any hardware manufactured from the non-conforming gas lot shall be segregated and tagged as well. The discrepancy report shall be dispositioned before any gas bottle of the same lot can be used.

11.0 FLOW DIAGRAM

11.1 Flow Chart for Raw Materials

Figure 11-1 Flow Chart for Raw Materials



11.2 Flow Chart for Breathing Gases

N/A

11.3 Flow Chart for Laboratory or Manufacturing Gases

Figure 11-2 Flow Chart for Laboratory of Manufacturing Gases

